Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
OFFICE OF ENGINEERING AND TECHNOLOGY SEEKS COMMENT ON TECHNOLOGICAL ADVISORY COUNCIL SPECTRUM POLICY RECOMMENDATIONS	)	ET Docket No. 17-340

COMMENTS OF SPACE EXPLORATION TECHNOLOGIES CORP.

Space Exploration Technologies Corp. ("SpaceX") hereby responds to the Office of Engineering and Technology's request for comment on the spectrum policy recommendations of the Commission's Technological Advisory Council ("TAC").[1] In these comments, SpaceX focuses on the TAC's recommendations for the adoption of risk-informed interference assessment ("RIIA") techniques.[2] In evaluating the potential interference environment caused by the interaction of radio systems, RIIA considers both the severity and likelihood of multiple scenarios, rather than a single worst-case outcome regardless of likelihood, in order to provide a more complete picture. It can thus provide objective information to aid the Commission in balancing the benefits of one system or service against its adverse technical impact on another. Indeed, RIIA can be applied in other areas where Commission licensees must share scarce resources. As

[1] *See* Public Notice, "Office of Engineering and Technology Seeks Comment on Technological Advisory Council Spectrum Policy Recommendations," DA 17-1165 (rel. Dec. 2, 2017) ("*Notice*").

[2] *See generally* FCC Technical Advisory Council, "A Quick Introduction to Risk-Informed Interference Assessment" (Apr. 1, 2015), *available at* http://transition.fcc.gov/bureaus/oet/tac/tacdocs/meeting4115/Intro-to-RIA-v100.pdf ("RIIA White Paper").

discussed below, SpaceX supports the TAC's recommendation that the Commission apply an RIIA approach more widely in assessing and resolving interference issues.

DISCUSSION

As explained in the RIIA White Paper, assessing the potential for interference between two or more radio systems based on a "worst case" analysis that considers the single scenario with the most severe consequence, regardless of its likelihood, provides only limited insight for policymakers. To the extent such an approach results in rules designed to avoid a severe but highly unlikely interference scenario, it can lead to unnecessarily restrictive rules that prevent operators from realizing the full potential of spectrum. By contrast, RIIA considers both the likelihood and the severity of potential interference scenarios. As illustrated in Figure 1 below, this type of analysis better captures the full range of potential outcomes and options, where even fairly certain interference may not be a concern if the severity is very low while very severe interference can be problematic even when it is much less likely to occur.

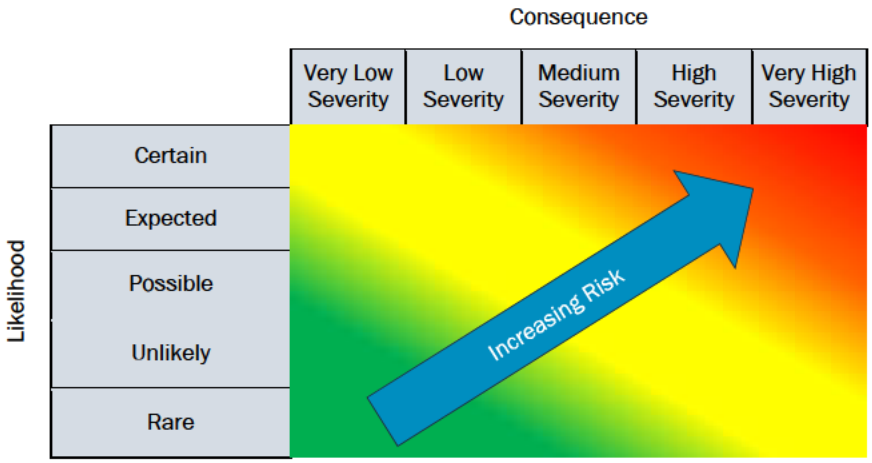

Figure 1. Conceptual Risk Chart

Thus, RIIA provides a methodology that better supports a systematic, quantitative analysis of interference hazards caused by the interaction between radio systems.[3] As the RIIA White Paper

[3] *See id.* at ii.

puts it, this approach results in "quantitative risk assessments that broaden regulatory analysis from 'What's the worst that can happen?' to 'What can happen, how likely is it, and what are the consequences?' and can thus provide a stronger evidence base for policy judgments."[4]

Conceptually, the structure of an RIIA analysis is fairly straightforward, composed of three major steps.

1. Make an inventory of all significant interference "hazard" modes;
2. Define a consequence metric to quantify impact of those hazards; and
3. Assess the likelihood and consequence of each hazard mode.

Aggregating the results of this process yields a probability-consequence matrix of hazards similar to Figure 1, which can then be used to inform regulatory decision making.

While the Commission is already familiar with techniques for identifying the potential sources of interference in a given case and the likelihood that such interference will occur, deciding how to define a consequence metric calls for careful consideration. As the RIIA White Paper notes, for example, a metric for the severity of interference "can be defined in many ways, from monetary impact (e.g. reduction in a service provider's profit) and service metrics (e.g. time period or percentage that a TV service is unavailable, bit error rates for mobile data services, or range reduction for radar systems) to RF metrics (e.g. probability that interfering power exceeds, or signal-to-noise ratio falls below, a threshold)."[5] In some cases, industry practice within a service may provide a recognized metric. In other cases, however, the Commission would need to evaluate and identify an appropriate metric among many competing options. Over time, more such metrics

[4] *Id.* at 1.

[5] *Id.* at 6.

can be agreed upon, and policy makers and affected parties can also achieve greater facility with evaluating such metrics in new contexts as they gain experience in applying the RIIA approach.

The potential benefits in terms of informing Commission decision making on spectrum issues justify implementing a more rigorous and consistent RIIA approach with all deliberate speed. In order to inject the relevant concepts into Commission deliberations, the TAC recommends that the Commission "start small, but start soon."[6] This will allow the Commission and interested parties to gain valuable experience with the RIIA approach as quickly as possible so that this dynamic new assessment tool can be applied to more important interference issues in the future.

In this regard, RIIA can be used to shed light on interference issues currently facing the Commission. For example, in response to the Commission's request for consideration of the effect of possible interference from satellites operating in low- and medium-Earth orbit ("LEO" and "MEO," respectively) that could decrease spectral efficiency, the TAC's Satellite Communication Plan Working Group ("Working Group") recently applied an RIIA framework to interference among proposed non-geostationary orbit ("NGSO") satellite systems operating in the V-band.[7] The Working Group determined that risk assessment could be used (1) to assess whether rules for NGSO-NGSO spectrum sharing are necessary at all, (2) if so, to distinguish between relatively significant and relatively insignificant hazards, and focus attention on the ones that were truly significant, and (3) to provide an analytical framework for technical studies.[8] At present, two

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6 *Id.* at ii.

7 *See* Satellite Communication Plan Working Group, "A Risk Assessment Framework for NGSO-NGSO Interference" (Dec. 6, 2017), *available at* https://transition fcc.gov/oet/tac/tacdocs/meeting12617/TAC-NGSO-risk-assessment-framework-v100-2017-12-06.pdf ("NGSO RIIA Paper").

8 *See id.* at 5.

international working parties are developing interference consequence metrics to apply in this context for each potential hazard mode.[9] Although the Working Group did not actually undertake such an RIIA analysis, it outlined a framework for undertaking such an assessment.

This issue was raised in the Commission's recent proceeding to update its rules for NGSO systems, through proposals to adopt on-axis power limitations for uplink earth station transmissions. While recognizing the utility of such a proposal, the Commission concluded that it would be "premature to adopt any additional technical limitations to promote sharing among NGSO FSS systems" at this time.[10] The RIIA analysis outlined by the Working Group provides a template for conducting an integral component of the analysis that can flesh out the record on this important issue. The Commission should consider opening a docket to further develop the Working Group's analysis as part of the "start small but start soon" approach recommended by the TAC.

The NGSO satellite context offers opportunities to apply the RIIA methodology in areas beyond interference issues. Just as NGSO licensees must share limited spectrum resources, so too must they share limited orbital resources. If the rules for sharing these resources do not reflect an appropriate balance of safety and efficiency, they could reduce productivity and even preclude certain business models. If anything, the consequences of failure to share space efficiently and safely may be even greater than failure to avoid interference, since the result could be significant damage to one or more satellites or even the creation of a hazard for other space operations that will persist for decades or much longer.

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[9] *Id.* at 23-24 (discussing work on metrics involving a percentage degradation in throughput from a reference value and unavailability).

[10] *Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters,* 32 FCC Rcd. 7809, ¶ 55 (2017).

As the Commission has recognized, "orbital debris poses a potential risk to the continued reliable use of these orbital regimes for space-based services and operations, as well as to the continued safety of persons and property in space and on the surface of the Earth."[11] However, it is not realistic to expect or require that operations in space will *never* result in the creation of any orbital debris, or that *every* object launched into space will be successfully placed into a storage orbit or burn up completely in the atmosphere at mission completion. The Commission must instead define an acceptable level of risk in order to craft rules with requirements that satellite operators can be required to achieve. Thus, "U.S. policy on orbital debris is the product of considerable work over the years to assess the risks posed by orbital debris, and to develop methods for mitigating those risks."[12] This has resulted in the adoption of some rules based on an RIIA-like analysis. For example, the Commission imposed a range of disclosure requirements on satellite applicants – a requirement that allows the Commission to examine whether an applicant has considered a large range of debris mitigation issues, but one that should entail minimal costs.[13]

The Commission's orbital debris mitigation rules are now over a decade old. Moreover, as the Commission recognized in 2004, "satellite system designs are emerging that involve large constellations of ultra-small satellites in which the redundancy permitted by a large number of satellites permits the reliability of any individual satellite in the constellation to be low without impacting the reliability of the constellation as a whole."[14] This new generation of cubesats and nanosats could be used to provide valuable niche services, but also pose novel operational and

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[11] *Mitigation of Orbital Debris*, 19 FCC Rcd. 11567, ¶ 4 (2004).

[12] *Id.* ¶ 10.

[13] *Id.* ¶¶ 17-18.

[14] *Id.* ¶ 28.

safety concerns. The Commission is reportedly preparing rulemakings for later this year both to address the smallsat issue and to update its orbital debris mitigation rules in light of advances in technology and a new generation of large NGSO systems currently under consideration.[15] As the Commission considers how best to tailor its rules going forward, a more rigorous RIIA approach should be used to identify and address the most significant potential hazards in a manner commensurate with their likelihood of occurrence.

SpaceX supports the TAC's recommendation that the Commission apply an RIIA approach more widely in assessing and resolving interference issues, as well as other issues involving shared use of limited resources. This initiative should begin immediately so that the Commission and all interested parties can gain familiarity with the RIIA methodology and can develop appropriate consequence metrics across a variety of sectors within the telecommunications industry. To this end, the Commission should build upon the work already begun by the Working Group by applying RIIA principles to the question of uplink interference between NGSO systems. The Commission should also include RIIA assessments in its upcoming rulemakings with respect to issues such as orbital debris mitigation and cubesat regulation, and expand to other areas as opportunities present themselves.

[15] *See, e.g.,* Matt Daneman, "NGSO Application Review Could Mean Approvals This Quarter," COMMUNICATIONS DAILY, at 8 (Jan. 17, 2018) (reporting upcoming rulemakings).

Respectfully submitted,

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January 31, 2018